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Fractionation and enzymatic processing of biomass for biorefinery applications

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Development of second generation (2G) biorefinery using biochemical-based processes has focused mostly on producing ethanol as liquid fuel. However the economic viability of this setup is questionable due to volatility in the crude oil price. Hence there is a need to find other potential value-added products from the existing lignocellulosic biomass feedstocks. Lignin, a major component of lignocellulosic biomass and the second most abundant organic polymer in Earth (1), has been rather overlooked in the conversion process. In current large scale 2G ethanol plants, biomass is hydrothermally pretreated and enzymatically hydrolyzed. The resulting lignin-rich residue is burnt to produce energy to power the operations in the plant, preventing its use as source of material. Moreover, lignin has also been known to impede enzymatic deconstruction of biomass through non-productive adsorption and the effect of hydrothermal pretreatment to lignin has not been well established (2). The research project aims to understand this effect and to modify lignin's properties in order to promote more efficient hydrolysis and better separation of lignin from carbohydrates.

The main focus in this study is the hydrophobic property of lignin. Hydrophobic interaction has been thought to be the main factor governing the non-productive adsorption of cellulases to lignin (3). Properties of hydrothermally pretreated lignin will be assessed by isolating the lignin through extensive enzymatic hydrolysis. Subsequently, the isolated lignin will be characterized and subjected to treatments. The effect of lignin variation is incorporated by using biomass of different botanical origin: corn stover, wheat straw and miscanthus. Treatment of lignin will be approached using enzymes, i.e. various esterases for the removal of lignin-carbohydrate complexes (LCCs) and laccase treatment for lignin modification. Isolated lignins, both before and after treatments, will be subjected to characterization of surface properties which include adsorption of cellulases, surface charge and hydrophobicity. The effect of treatments towards enzymatic hydrolysis yield will also be assessed.

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